Frequency Standards for mm and submm Very Long Baseline Interferometry: Achieving 10micro-arcsecond resolution.

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VLBI is a powerful astronomical technique that allows data from widely separated radio telescopes to be combined into interferometric arrays that can image the sky with exceptional angular resolution. At the heart of a VLBI station is a highly stable frequency reference that locks heterodyne receivers and enables the phase of radiation from a cosmic source to be preserved. Subsequent correlation of data streams from two VLBI stations provides fourier components of sky brightness, and with many antennas, an accurate image of the radio sky can be reconstructed with an angular resolution equal to the ratio of observing wavelength to antenna separation. At the highest frequencies and longest baselines, angular resolutions approach 30 micro arcseconds, over a thousand times finer than the Hubble Space Telescope. With such resolution, a number of astrophysical phenomena can be studied in detail, including the Super Massive Black Hole candidate, SgrA*, at the center of the Milky Way Galaxy. To maintain phase coherence for observing wavelengths shortward of 1.3mm requires frequency standards to be stable over 1-10 second intervals, which is a coherence time set by atmospheric turbulence. Historically, Hydrogen masers have been used as VLBI references, but for short wavelength observations new frequency sources are available that outperform masers over the integration times of interest. I will discuss the stability requirements for VLBI and describe how future VLBI experiments can image the accretion disk and Event Horizon of the black hole at the Galactic Center.